Programme Title: MSci Physics with Data Science

# Programme Specification (UG)

| | |
|---|---|
| Awarding body / institution: | Queen Mary University of London |
| Teaching institution: | Queen Mary University of London |
| Name of final award and programme title: | MSci Physics with Data Science |
| Name of interim award(s): | CertHE; DipHE; BSc |
| Duration of study / period of registration: | 4 years |
| QMUL programme code / UCAS code(s): | F30T |
| QAA Benchmark Group: | Physics |
| FHEQ Level of Award : | Level 7 |
| Programme accredited by: | Institute of Physics |
| Date Programme Specification approved: | |
| Responsible School / Institute: | School of Physical and Chemical Sciences |

Schools / Institutes which will also be involved in teaching part of the programme:

Collaborative institution(s) / organisation(s) involved in delivering the programme:

## Programme outline

This 4-year programme follows the syllabus of the Institute of Physics (IoP) accredited MPhys/MSci in Physics. It covers the whole of the "core of Physics" as specified by the IoP in the compulsory modules, and adds an additional compulsory stream of modules in statistics, computer programming, and data science topics. A range of optional modules in more advanced topics in both physics and data science are provided in the third and fourth years, in addition to a substantial research component in the fourth year. The programme is designed to meet IoP accreditation requirements for an undergraduate Physics degree, while also providing a balanced education in modern programming and data science techniques.

An MSci graduate should be able to enter further training at MSc/PhD level or enter any of a number of other careers which use the transferable skills gained during their studies, but there is a particular focus on preparedness for data science, computer programming, and other traditional career destinations for physicists. The programme is structured such that a graduate would not need additional postgraduate study in order to be qualified for many roles in these lines of work. A number of compulsory professional development modules, including extended research projects in the 3rd year that involve research projects hosted by external employers (where the student is able to find an appropriate host) or academic researchers, are geared towards developing a portfolio of documented data science skills that will enhance the graduate's employability.

Programme Title: MSci Physics with Data Science

## Aims of the programme

We aim to:
i. teach physics of high quality within an excellent research environment;
ii. recruit students able to benefit from a university education;
iii. provide a programme that enables students with a variety of educational backgrounds to pursue physics as a subject;
iv. provide access to such variety of modules, including those from other disciplines, as to enable students to tailor their studies to their own needs and interests;
v. instill in our students an understanding of the working of the physical world;
vi. encourage students to develop transferable skills that are applicable to a variety of careers;
vii. provide a programme that prepares students, where appropriate, for a range of professional careers in physics and data science.
viii. provide opportunities for students to appreciate the beauty of physics and to develop a desire for learning.
ix. provide opportunities for students to prepare for the workplace and gain professional experience in relevant skills for data science careers.

## What will you be expected to achieve?

Students successfully completing this programme will be expected to achieve the outcomes listed below.

In addition, they will be expected to produce a portfolio consisting of no less than 6 written technical reports on practical data science problems (in physics and more generally) that students have solved during the course of their degree. Students will collect examples of their practical data science work into a digital portfolio to demonstrate to potential employers. The portfolio will be built up over the course of 4 years, from assessed work from several modules across the programme, and will not be separately assessed. Although there is no assessment, we will award a prize (e.g. a certificate) to the finalist(s) with the best portfolio each year.

**Please note that the following information is only applicable to students who commenced their Level 4 studies in 2017/18, or 2018/19**

In each year of undergraduate study, students are required to study modules to the value of at least 10 credits, which align to one or more of the following themes:

- networking
- multi- and inter-disciplinarity
- international perspectives
- enterprising perspectives.

These modules will be identified through the Module Directory, and / or by your School or Institute as your studies progress.

| Academic Content: | |
|---|---|
| A 1 | Have acquired a core knowledge of physics. |
| A 2 | Be able to communicate this knowledge. |
| A 3 | Have acquired essential skills in the use of computers for word-processing, spreadsheet computing and the acquisition and manipulation of data. |

Queen Mary University of London

| | |
|---|---|
| A4 | Have acquired essential skills in measurement and the analysis of uncertainties of observation. |

| Disciplinary Skills - able to: | |
|---|---|
| B1 | Have acquired essential skills in the art of scientific report-writing and in the oral presentation of technical material. |
| B2 | Be able to apply scientific methods to the analysis of problems. |
| B3 | Have seen and understood the application of core physics to one or two specialised areas of study. |
| B4 | Have acquired an understanding of the workings of the physical world. |
| B5 | Be able to appreciate the role of science in general, and of physics in particular, within a broader range of human cultural activity. |

| Attributes: | |
|---|---|
| C1 | To acquire and apply knowledge in a rigorous way. |
| C2 | To connect information and ideas within their field of study. |
| C3 | To adapt their understanding to new and unfamiliar settings. |
| C4 | To develop the ability to reflect upon and asses their own progress. |

## How will you learn?

Our programme is constructed within a modular course structure in which each student takes eight modules per year (or nine if some compulsory non-credit-bearing modules are included). Our overall strategy is to achieve a balance, appropriate to the aims of each course unit, between teaching (lectures; practical laboratory work, including computer labs; small-group tutorials) and learning by students (peer discussion; exercise classes; coursework and essay assignments; independent work in laboratories and computer studies; teach-yourself computer packages and the Internet; videos; textbooks and supplementary reading).

Exercise classes or laboratories are provided for all compulsory modules which are used to develop the specific skills needed. Two general physics laboratories are used to develop experimental skills, including the acquisition of data and the analysis of uncertainties of observation. In addition students learn to write a scientific account of their experimental observation. Finally, compulsory independent projects (in the 3rd and 4th years) are used to develop students' investigative and communication skills, and to develop a portfolio of practical data science problems that they have solved.

## How will you be assessed?

Assessment is by a mixture of continuous assessment and formal written examinations at the end of each year. We use a variety of in-course assessments to enable students to get quick feedback as to their performance. These include weekly coursework (marked and returned on a weekly basis), essay assignments, mid-term tests carried out in a lecture slot, performance in exercise classes and tutorials, laboratory and project reports. These in-course assessments are combined with formal final written examination results and oral examinations (on project modules) to produce the final mark for each module. The precise mixture of in-course and final exam marks to give the overall mark varies between different modules and is specified in the detailed module description given in the Student Handbook and on the relevant QMPlus module web page.

Programme Title: MSci Physics with Data Science

Assessment for independent projects involving a project optionally hosted by an external employer (during the Data Science Project portfolio module) will take into account a performance assessment questionnaire filled out by the employer, but the final grading will be determined through an assessment of the project report and an oral examination by QMUL academics, in the same manner as for internally-supervised projects.

## How is the programme structured?

Please specify the structure of the programme diets for all variants of the programme (e.g. full-time, part-time - if applicable). The description should be sufficiently detailed to fully define the structure of the diet.

The programme consists of core, compulsory and elective modules. All undergraduate students at Queen Mary take 120 credits a year.
An MSci degree consists of 480 credits.

Most modules are worth 15 credits which means that students normally take 8 modules a year. Students are required to take all modules marked as 'core' and 'compulsory' below. The entirety of the first and second years of study are core/compulsory modules, but significant module choice is available in the third and fourth years. Students must pass any core modules to be eligible to progress to the next academic year. Failure to pass any core modules will result in students being transferred to the equivalent non-data science MSci.

Where modules are indicated as "elective", students may choose whether or not to take the module. Where there is space in the curriculum, students at level 6 may take up to 15 credits per academic year from another School at Queen Mary. Students who chose this option are responsible for finding their own modules and complying with all registration requirements.

As well as covering the core Physics curriculum, this programme includes 30 credits of data science modules in each of Years 1 and 2, plus 60 or more credits of data science modules in Year 3. (Note that some of the data science modules are also either core or elective modules on the BSc Physics programme.) Either 30 or 45 credits of data science modules are required in Year 4, including one core module (Practical Machine Learning), and either one or two elective modules that are provided by the School of Electronic Engineering and Computer Science (EECS) or the School of Mathematical Sciences (SMS).

The elective data science modules available in Year 4 are organised into "mini-tracks" that will help data science-oriented students specialise towards certain common target careers if desired. These are:
- Artificial intelligence: Introduction to Computer Vision (ECS709U), Risk and Decision-Making for Data Science and AI (ECS7005P)
- Computer vision and VR: Computer Graphics (ECS610U), Machine Learning for Visual Data Analysis (ECS797U)
- Statistics for global challenges: Time Series (MTH6139), Applied Statistics (MTH705U)

Students are able to mix and match between tracks if desired; they are only provided for guidance. A maximum of 2 modules may be chosen from this list, while the remaining credits must be made up from the available level 7 physics modules.

Academic Year of Study FT - Year 1

| Module Title | Module Code | Credits | Level | Module Selection Status | Academic Year of Study | Semester |
|---|---|---|---|---|---|---|
| Professional Skills for Scientists | SPA4601 | 15 | 4 | Compulsory | 1 | Semester 2 |
| Mathematical Techniques 1 | SPA4121 | 15 | 4 | Compulsory | 1 | Semester 1 |
| Classical Physics | SPA4401 | 15 | 4 | Compulsory | 1 | Semester 1 |
| Scientific Measurement | SPA4103 | 15 | 4 | Compulsory | 1 | Semester 1 |

Programme Title: MSci Physics with Data Science

| Module Title | Module Code | Credits | Level | Module Selection Status | Academic Year of Study | Semester |
|---|---|---|---|---|---|---|
| Modern Physics | SPA4402 | 15 | 4 | Compulsory | 1 | Semester 1 |
| Electric and Magnetic Fields | SPA4210 | 15 | 4 | Compulsory | 1 | Semester 2 |
| Mathematical Techniques 2 | SPA4122 | 15 | 4 | Compulsory | 1 | Semester 2 |
| Introduction to Data Science | SPA4131 | 15 | 4 | Core | 1 | Semester 2 |

Academic Year of Study FT - Year 2

| Module Title | Module Code | Credits | Level | Module Selection Status | Academic Year of Study | Semester |
|---|---|---|---|---|---|---|
| Thermodynamics | SPA5219 | 15 | 5 | Compulsory | 2 | Semester 1 |
| Quantum Mechanics A | SPA5319 | 15 | 5 | Compulsory | 2 | Semester 1 |
| Physics Laboratory | SPA5201 | 15 | 5 | Compulsory | 2 | Semester 2 |
| Condensed Matter A | SPA5228 | 15 | 5 | Compulsory | 2 | Semester 2 |
| Electromagnetic Waves and Optics | SPA5222 | 15 | 5 | Compulsory | 2 | Semester 2 |
| Introduction to Scientific Computing | SPA5666 | 15 | 5 | Core | 2 | Semester 1 |
| Practical Techniques for Data Science | SPA5131 | 15 | 5 | Core | 2 | Semester 2 |
| Nuclear Physics and Astrophysics | SPA5302 | 15 | 5 | Elective | 2 | Semester 1 |
| Mathematical Techniques 3 | SPA5218 | 15 | 5 | Elective | 2 | Semester 1 |

Academic Year of Study FT - Year 3

Programme Title: MSci Physics with Data Science

| Module Title | Module Code | Credits | Level | Module Selection Status | Academic Year of Study | Semester |
|---|---|---|---|---|---|---|
| Statistical Physics | SPA6403 | 15 | 6 | Compulsory | 3 | Semester 2 |
| Physics Review Project | SPA6913 | 15 | 6 | Core | 3 | Semesters 1 & 2 |
| The Physics of Galaxies | SPA6305 | 15 | 6 | Elective | 3 | Semester 2 |
| Spacetime and Gravity | SPA6308 | 15 | 6 | Elective | 3 | Semester 1 |
| Statistical Data Analysis | SPA6328 | 15 | 6 | Core | 3 | Semester 1 |
| Mathematical Techniques 4 | SPA6324 | 15 | 6 | Elective | 3 | Semester 1 |
| Quantum Mechanics B | SPA6413 | 15 | 6 | Elective | 3 | Semester 1 |
| Elementary Particle Physics | SPA6306 | 15 | 6 | Elective | 3 | Semester 2 |
| Physical Cosmology | SPA6311 | 15 | 6 | Elective | 3 | Semester 1 |
| Quantum Mechanics and Symmetry | SPA6325 | 15 | 6 | Elective | 3 | Semester 2 |
| Professional Skills for Data Science | SPA6331 | 15 | 6 | Elective | 3 | Semester 1 |
| Machine Learning and Artificial Intelligence | SPA6330 | 15 | 6 | Core | 3 | Semester 2 |

Academic Year of Study FT - Year 4

| Module Title | Module Code | Credits | Level | Module Selection Status | Academic Year of Study | Semester |
|---|---|---|---|---|---|---|
| Relativistic Waves and Quantum Fields | SPA7018U | 15 | 7 | Elective | 4 | Semester 1 |
| Relativity and Gravitation | SPA7019U | 15 | 7 | Elective | 4 | Semester 1 |
| Stellar Structure and Evolution | SPA7023U | 15 | 7 | Elective | 4 | Semester 1 |

Programme Title: MSci Physics with Data Science

| Module Title | Module Code | Credits | Level | Module Selection Status | Academic Year of Study | Semester |
|---|---|---|---|---|---|---|
| Solar System | SPA7022U | 15 | 7 | Elective | 4 | Semester 1 |
| Functional Methods in Quantum Field Theory | SPA7024U | 15 | 7 | Elective | 4 | Semester 1 |
| Differential Geometry in Theoretical Physics | SPA7027U | 15 | 7 | Elective | 4 | Semester 1 |
| Practical Machine Learning | SPA7033U | 15 | 7 | Core | 4 | Semester 2 |
| Extrasolar Planets and Astrophysical Discs | SPA7009U | 15 | 7 | Elective | 4 | Semester 2 |
| The Galaxy | SPA7010U | 15 | 7 | Elective | 4 | Semester 2 |
| Astrophysical Plasmas | SPA7004U | 15 | 7 | Elective | 4 | Semester 2 |
| Advanced Quantum Field Theory | SPA7001U | 15 | 7 | Elective | 4 | Semester 2 |
| Advanced Cosmology | SPA7028U | 15 | 7 | Elective | 4 | Semester 2 |
| Supersymmetric Methods in Theoretical Physics | SPA7031U | 15 | 7 | Elective | 4 | Semester 2 |
| An Introduction to Strings and Branes | SPA7032U | 15 | 7 | Elective | 4 | Semester 2 |
| Introduction to Computer Vision | ECS709U | 15 | 7 | Elective | 4 | Semester 1 |
| Risk and Decision-Making for Data Science and AI | ECS7005P | 15 | 7 | Elective | 4 | Semester 2 |
| Computer Graphics | ECS610U | 15 | 7 | Elective | 4 | Semester 1 |
| Machine Learning for Visual Data Analysis | ECS797U | 15 | 7 | Elective | 4 | Semester 2 |
| Time Series | MTH6139 | 15 | 7 | Elective | 4 | Semester 2 |
| Applied Statistics | MTH705U | 15 | 7 | Elective | 4 | Semester 2 |
| Physics Investigative Report | SPA7015U | 30 | 7 | Compulsory | 4 | Semesters 1 & 2 |

Programme Title: MSci Physics with Data Science

| Module Title | Module Code | Credits | Level | Module Selection Status | Academic Year of Study | Semester |
|---|---|---|---|---|---|---|
| Radiative Transfer and Astrochemistry | SPA7036U | 15 | 7 | Elective | 4 | Semester 2 |

## What are the entry requirements?

Grades AAB at A-Level. This must include grade A or above in both A-Level Mathematics and Physics. Excludes General Studies.
IB International Baccalaureate Diploma with a minimum of 34 points overall, including 6,6,5 from three Higher Level subjects. This must include a minimum of 6 in both Higher Level Mathematics, and Higher Level Physics.
BTEC BTEC qualifications are not considered for entry to this programme.
Access HE Access qualifications are not considered for entry to this programme.
GCSE Minimum five GCSE passes including English and Maths at grade C or 4.

## How will the quality of the programme be managed and enhanced?

Each school/institute operates a Learning and Teaching Committee, or equivalent, which advises the School/Institute Director of Education on all matters relating to the delivery of taught programmes at school level including monitoring the application of relevant QM policies and reviewing all proposals for module and programme approval and amendment before submission to Taught Programmes Board. Student views are incorporated in the committee's work in a number of ways, such as through student membership, or consideration of student surveys.

All schools/institutes operate an Annual Programme Review of their taught undergraduate and postgraduate provision. APR is a continuous process of reflection and action planning which is owned by those responsible for programme delivery; the main document of reference for this process is the Student Experience Action Plan (TPAP) which is the summary of the school/ institute's work throughout the year to monitor academic standards and to improve the student experience. Students' views are considered in this process through analysis of the NSS and module evaluations.

## How do we listen to and act on your feedback?

The Staff-Student Liaison Committee provides a formal means of communication and discussion between schools/institutes and its students. The committee consists of student representatives from each year in the school/institute together with appropriate representation from staff within the school/institute. It is designed to respond to the needs of students, as well as act as a forum for discussing programme and module developments. Staff-Student Liaison Committees meet regularly throughout the year.

## What academic support is available?

The Department of Physics and Astronomy provides each student with an academic advisor, normally the same member of staff for the duration of a student's studies, who can provide academic and pastoral guidance. Additionally the School has a dedicated Student Support Officer who is available to discuss any student related problem. The School runs an open door policy which encourages the students to come and talk to their advisor, other academics or the dedicated Student Support Officer. The School also actively participates in the QMUL Peer Assisted Study Scheme (PASS).

The Senior Tutor has overall responsibility for academic support and pastoral care within the Department. The Senior Tutor also has a key role in overseeing the School's attendance policy. The Senior Tutor will address any problems that cannot be resolved by a student's academic adviser or the Student Support Officer.

Programme Title: MSci Physics with Data Science

## Programme-specific rules and facts

To progress into the next year of the programme, students must pass any modules listed as core. Students failing this progression hurdle will be transferred to the equivalent non-data-science MSci Physics programme, entering into the corresponding year of that programme with the appropriate progression hurdles from that programme to be applied.

Students are required to have written a portfolio of at least 6 technical reports describing practical data science problems that they have solved over the course of the degree programme. Two of the constituent reports must have been completed as part of the Data Science Project Portfolio module. A third must be completed as part of the Year 4 Physics Research Project. The remaining 3 may be selected from assessed coursework written during any module with an eligible data science-related coursework component, e.g. the "Physics Laboratory", "Professional Skills for Data Science", "Statistical Data Analysis", and "Machine Learning and Artificial Intelligence" modules. Students may choose to include additional written reports, e.g. on projects carried out as part of summer studentships and internships. Certificates of merit will be awarded to the students with the best portfolios at the conclusion of Year 4, as judged by the programme director.

## Specific support for disabled students

Queen Mary has a central Disability and Dyslexia Service (DDS) that offers support for all students with disabilities, specific learning difficulties and mental health issues. The DDS supports all Queen Mary students: full-time, part-time, undergraduate, postgraduate, UK and international at all campuses and all sites.

Students can access advice, guidance and support in the following areas:
• Finding out if you have a specific learning difficulty like dyslexia
• Applying for funding through the Disabled Students' Allowance (DSA)
• Arranging DSA assessments of need
• Special arrangements in examinations
• Accessing loaned equipment (e.g. digital recorders)
• Specialist one-to-one "study skills" tuition
• Ensuring access to course materials in alternative formats (e.g. Braille)
• Providing educational support workers (e.g. note-takers, readers, library assistants)
• Mentoring support for students with mental health issues and conditions on the autistic spectrum.

## Links with employers, placement opportunities and transferable skills

The primary mode of engagement with employers is through the 3rd year compulsory "Data Science Project Portfolio" module. Students will be supported to carry out two semester-long projects involving hands-on statistical data analysis that include but are not limited to physics research problems. A range of possible projects, curated by the academics managing the course, will be presented to the students each semester, which can be performed via: short projects where the student goes to work on-site with employers (where the student is able to successfully find an employer to partner with); as jointly-supervised projects, where the student is hosted at QMUL but meets regularly with a partner employers; or as QMUL-only projects with research academics (and which may include inter-disciplinary working, e.g. across different schools). There will be a bias towards connecting students to the first two types of project, with the latter seen more as a fallback depending on project/employer availability, the size of the cohort, and whether the student is successful in finding an appropriate employer to partner with. In each case the students will have a principal academic project adviser, who will be responsible for student welfare and final assessment. Projects will be developed in collaboration with academics and employers, either through our existing relationships with companies such as IBM and UKAEA (who have already expressed a keen interest), or our cross-faculty contacts through the Institute for Advanced Data Science. Existing support to help manage relationships with employers etc. is already available within the School, as we can leverage the resources already in place to support the Physics with Professional Experience programme.

In terms of transferable skills, there is already a strong focus on critical thinking, analysis, and mathematical skills as part of the core physics modules. The compulsory data science modules will add significant additional computer programming, project management, and presentation skills, as well as more specific expertise in statistical analysis methods that are in widespread use in industry. The data science project portfolio (see above) is specifically designed to demonstrate to employers the transferable skills that the graduate has developed. The data science mini-tracks in Year 4 are designed to help students specialise towards certain careers.

Programme Title: MSci Physics with Data Science

## Programme Specification Approval

| | |
|---|---|
| **Person completing Programme Specification:** | Lesley Howell |
| **Person responsible for management of programme:** | Christopher White as DTL for DPA |
| **Date Programme Specification produced / amended by School / Institute Learning and Teaching Committee:** | 28/10/21 |
| **Date Programme Specification approved by Taught Programmes Board:** | |

Queen Mary University of London